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# SOME FACTORS INFLUENCING THE DISTRIBUTION OF MAMMALS IN OHIO[1]

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## INTRODUCTION

THE following study was made to determine the amount of correlation between physiographic provinces and the distribution of mammals. Ohio was chosen as a field for study, for within the state are found four well-defined physiographic provinces, which, although distinct, do not differ greatly in temperature, rainfall, elevation, or geologic history. Field work was carried on during the summers of 1924, 1925, and 1926, and during the winter vacations.

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## Methods of Field Study Employed

Major forest habitats, as little modified by man as it was possible to find, were trapped for periods of varying length, ranging from a few days to ten days or more. An effort was made to select habitats in regions that would prove significant because of either vegetation or geographical location. Extensive collecting was done in the beech-maple and oak-hickory forest associations. Minor habitats were also studied.

In each locality where work was carried on the habitats were numbered and worked as stations, one station representing a trap line of any length within a clearly defined association. Thus totals may be secured by combining the catch of the stations either by physiographic provinces, forest types, or in any way that totals may be desired. The number of traps in a line varied, but was usually between 60 and 200; the line was maintained for a period of 4 to 14 days, but since traps were continually added to, taken up, or moved about, little of quantitative value can be deduced either from the number of traps or the number of "trap nights."

Stations were located in Ashtabula, Ashland, Butler, Carroll, Harrison, Hocking, Lawrence, Preble, Ross, and Wayne counties. About 30 stations were worked. These stations are only roughly comparable, for they are of different sizes and the studies made of them varied in intensity and duration as well as in the season of the year.

Each habitat is described, with a list of the mammals taken, since it is hoped that as more ecological material is collected these data may help in their interpretation.

## Physiography

Portions of four physiographic provinces lie within the state of Ohio: (1) Glaciated Plains in the central and western parts; (2) Lake Plains, to the north; (3) Glaciated Section, the western and northern portions of the Allegheny Plateau to the east; and (4) the Unglaciated Section to the southeast.

Three fourths of the area is occupied by a glaciated plain of slight relief divided into (1) the Till Plains; (2) the Lake

Plains; and (3) the Glaciated Plateau. The roughest topography is in the "hill country" on the Unglaciated Plateau, of moderate elevation but maturely dissected by deep-lying

Figure 1

streams. The Lake Plains are very level, in places swampy; the Till Plains are remarkably smooth, with the surface broken by morainic ridges and the valleys of the larger streams. The Glaciated Plateau presents an intermediate

condition, for the deeper valleys were filled with glacial drift and the higher hills rounded off (Peattie, 1923, pp. 3–7, Fig. 1).

The soils of the western part of the state are chiefly of the limestone type; those of the eastern part are of sandstone and shale. The mixing action of the ice-sheets left soils of more uniform type than those found in the unglaciated regions (Coffey and Rice, 1915, pp. 23–24, map).

### Climate

The climate is of the Continental type, with extremes of heat and cold, but is fairly uniform throughout the state. The growing season ranges from 178 days in the south to 150 days in the north. Similarly mean annual precipitation is fairly uniform, ranging from 31 to 43 inches (Smith, 1912, pp. 187–188, figs. 2, 3 and 8).

### Mammal Habitats in Ohio

#### *The beech-maple habitat*

Beech-maple forest appears to be the ecological climax in Ohio, with oak-hickory as subclimax. Roughly speaking, beech-maple is found more often on the Till Plains and Lake Plains and covers a decreasing area in the Glaciated Plateau province until it is found only in the denser upland forests and the lower moister slopes in the Unglaciated Plateau province. Beech-maple forest unmixed with oak or ash is rare, and is confined to the glaciated region.

This type of forest is dominated by either beech (*Fagus grandifolia*) or sugar maple (*Acer saccharum*) or both, but is not limited to a pure stand of either or both species. White oak (*Quercus alba*), white ash (*Fraxinius americana*), tulip (*Liriodendron tulipifera*), white elm (*Ulmus americana*), and a variety of other species occur with the two dominant species, but except in a few places do not occupy much of the territory. Mixed with the climax and subclimax types are species that are most numerous in the various sections of the state nearest to what may be termed a pass. Thus in the

west, where the Lake Plains form a broad pass across Indiana and into the Mississippi Valley, ironwood, linden, and cottonwood are most common, but southwestern species are most numerous in the southwestern part of the state, diverging eastward and northward along the Upper Ohio and the two Miami and the Scioto rivers. Southeastern and southern forms, such as chestnut, chestnut oak, scrub pine, and cucumber, tulip, gums, and cherry, are more conspicuous upon the unglaciated area than elsewhere. Hemlock and white pine from the northeast are found abundantly in the northeastern corner of the state and also on the glaciated portions of the plateau where they occupy the deep and north-facing ravines (Sears, 1925, pp. 148–149).

In one station sugar maple constituted 90 per cent of the stand; more frequently each of the two dominants compose from 25 per cent to 45 per cent of the stand.

The station located in Ashtabula County differed from all the others in the beech-maple forest habitat in that the dominant tree was hemlock (*Tsuga canadensis*), followed in point of abundance by white pine (*Pinus strobus*). Beech, sugar maple, white ash, and a few white oaks were present. The station is placed, however, in the beech-maple type.

### *Oak-hickory habitat*

The oak-hickory forest reaches its highest development on the Allegheny Plateau, but occurs over all Ohio, though it is unimportant in the Lake Plains province. In the Glaciated Plateau province it occurs where overdrainage has kept out beech-maple on the drier hills, and following a swamp succession. In the Till Plains province the oak-hickory stage following ponding due to glacial action is the more important, but oak-hickory also occupies the drier, prairie-like areas.

This type of forest is composed of white oak, black oak (*Q. velutina*), shagbark hickory (*Carya ovata*), pignut (*C. glabra*), with chestnut (*Castanea dentata*) and chestnut oak (*Q. prinus*) on the ridges and slopes. The swamp succession of oak-hickory differs from the upland, but is not considered.

As would be expected, oak-hickory, the subclimax forest, does not show the constancy of the beech-maple. The diversity manifests itself in the large number and species of trees that are found associated with the dominant. All degrees of intergradation of the climax and subclimax may be found in the several physiographic provinces.

The following stations were studied:

Beech-maple habitat
- Unglaciated Plateau Province
  - Harrison County, Bowerston. Station 1
  - Ross County, Hopetown. Station 2
  - Lawrence County, Hanging Rock. Station 3
- Glaciated Plateau Province
  - Wayne County, Applecreek. Station 4
  - Ashland County, Loudenville. Station 5
  - Wayne County, Overton. Station 6
  - Ashtabula County, Farnham. Station 7
- Till Plains Province
  - Butler County, College Corner. Station 8
  - Preble County, southeast section. Station 9

Oak-hickory habitat
- Unglaciated Plateau Province
  - Carroll County, Carrollton, Station 10
  - Carroll County, Carrollton. Station 11
  - Carroll County, Carrollton. Station 12
  - Ross County, Alma. Station 13
  - Lawrence County, Hanging Rock. Station 14
  - Ross County, Hopetown. Station 15
- Glaciated Plateau Province
  - Ashland County, Loudenville. Station 16
  - Wayne County, Applecreek. Station 17
  - Wayne County, Wooster. Station 18
  - Ashtabula County, Farnham. Station 19

Minor habitats (mostly not natural)
- Unglaciated Plateau Province
  - Pastured field habitat
    - Harrison County, Bowerston. Station 27
- Glaciated Plateau Province
  - Small marsh habitat
  - Wayne County, Overton. Station 20
  - Abandoned field habitat
    - Ashland County, Loudenville. Station 21

Ashland County, Loudenville. Station 22
Orchard habitat
Ashland County, Loudenville. Station 23
Cultivated field habitat
Wayne County, Craigton. Station 24
Pastured field habitat
Wayne County, Craigton. Station 24a
Ruderal habitat
Wayne County, Craigton. Station 25
Ashland County, Rowsburg. Station 26

## Annotated List of Mammals

*Didelphis virginiana virginiana:* Opossum

Unglaciated Plateau Province
Beech-maple ..... 1
Oak-hickory .....Reported 5

Glaciated Plateau Province
Beech-maple .....Reported 6
Oak-hickory .....Reported 3
Minor habitats..... 1
Till Plains Province
Beech-maple ..... 1

The opossum is found wherever wood-lots or more extensive woods remain, unless thinned out by persistent trapping or hunting. Specimens were taken at Loudenville, Haysville, and Craigton.

*Parascalops breweri:* Hairy-tailed or Brewer's Mole

Unglaciated Plateau Province
Beech-maple ..... 2
Glaciated Plateau Province
Beech-maple ..... 2
Oak-hickory ..... 1

Reported from northeastern Ohio, Cleveland, Ellsworth, and Ravenna (Jackson, 1915, pp. 77, 82), abundant in some parts of eastern Ohio with records from Cuyahoga, Summit, Franklin, and Adams counties (Hine, 1912, p. 495). Taken in Wayne, Harrison, and Ashtabula counties. This mole appears to be more abundant on the Allegheny Plateau and in fairly moist soil, but is by no means confined either to the region mentioned or to one type of habitat.

*Scalopus aquaticus machrinus:* Prairie Mole

Except for one record from Columbiana County (Jackson, 1915, p. 44) the prairie mole is reported only from the central and western portions of the state. Since very little work was done in open fields, it is not surprising that no specimens of this species were taken in the course of this study.

*Condylura cristata:* Star-nosed Mole

Glaciated Plateau Province
Minor habitats..... 4

Reported from Cleveland, Ellsworth and Garretteville (Jackson, 1915, p. 99), and from Summit, Ashtabula, Cuyahoga, and Richland counties "and I suspect it to occur throughout northern Ohio, at least where suitable conditions are to be found." (Hine, 1915, p. 496.) Four specimens were captured in a colony located on the "muck bottoms" at Craigton, Wayne County.

*Sorex fumeus fumeus:* Smoky Shrew

Unglaciated Plateau Province
Beech-maple ..... 2
Oak-hickory ..... 5

Glaciated Plateau Province
Beech-maple ..... 1

Specimens were collected at Overton, Wayne County, at Carrollton, Carroll County, and at Hopetown and Chillicothe, Ross County. All except one were taken on rainy nights. At Hopetown no short-tailed shrews were collected in the station where two of the smoky shrews were trapped, and at Chillicothe only four short-tailed shrews were taken; three smoky shrews were captured during the same period.

*Sorex cinereus cinereus:* Masked Shrew

Reported from the Glaciated Plateau province in Mahoning, Summit, and Ashtabula counties (Hine, 1912, p. 495). No specimens of this shrew were taken.

*Cryptotis parva:* Small short-tailed Shrew

Reported from the Glaciated Plateau in Summit and Ashtabula counties and from the Till Plains in Franklin and Hamilton counties (Hine, 1912, p. 495).

*Blarina brevicauda talpoides:* Short-tailed Shrew

Unglaciated Plateau Province
- Beech-maple ..... 30
- Oak-hickory ..... 39

Glaciated Plateau Province
- Beech-maple ..... 42
- Oak-hickory ..... 14

Till Plains Province
- Beech-maple ..... 34

Taken in almost every station: Wayne, Ashtabula, and Ashland counties in the Glaciated Plateau province; Ross, Lawrence, Harrison, and Carroll counties in the Unglaciated Plateau province; and in Butler and Preble counties in the Till Plains province. It was most abundant in woods where the soil was moist but well-drained and where logs were numerous. In such places it was sometimes the most abundant species of mammal.

*Euarctos americanus americanus:* Black Bear

The last native bear reported from Ohio was killed in Paulding County in 1881 (Moseley, 1906, p. 504). Recently several bears have been introduced into the game refuge near Ironton. The place of origin of these specimens appears to be unknown to the Division of Fish and Game, which was responsible for the introduction.

*Procyon lotor lotor:* Raccoon

Unglaciated Plateau Province
- Beech-maple .....Reported 4
- Oak-hickory .....Reported 3

Glaciated Plateau Province
- Beech-maple .....Reported 6
- Oak-hickory .....Reported 3

Till Plains Province
- Beech-maple .....Reported 2

State wide in distribution wherever there is enough protection in the form of woods. Tracks were seen in Harrison, Wayne, Preble, and Ashland counties.

*Mustela cicognanii cicognanii:* Small Weasel

Reported from Oberlin (Wright, 1905, p. 251), but the report has not been verified. Also reported from New Bremen (Henninger, 1921, p. 239).

*Mustela rixosa allegheniensis:* Least Weasel

Recorded from Jefferson, Mahoning, Summit, Franklin, Darke, and Auglaize counties (Heninger, 1923, p. 121). Specimens from Lucas and Huron counties are in the Museum of Zoology, University of Michigan.

*Mustela noveboracensis noveboracensis:* New York Weasel

This is the common weasel in the state. Specimens were taken in Wayne and Ashland counties.

*Mustela vison mink:* Mink

The distribution of this fur-bearer follows the water courses. Although rare, a few are taken every year. One was trapped north of Wooster in 1924.

*Lutra canadensis canadensis:* Otter

Otter bred on the Mohican River at the mouth of Ball Alley Run about ten years ago, but since they were disturbed, left as soon as the young could travel.

*Mephitis nigra:* Skunk

This mammal is found everywhere in the state where there is the least protection. It was seen in large towns, in fields and in the woods, and many dead skunks were seen along the roads.

*Taxidea taxus taxus:* Badger

Badgers existed in Lucas County till 1838. (Coues, 1877, p. 264.) Hine has some recent records and two Ohio specimens.

*Vulpes fulva:* Red Fox

Occurs everywhere in rough country, and in surprisingly large numbers when the population of the state is considered. Specimens were secured from Ashland and Wayne counties. The weight of the largest was slightly over 11 pounds.

*Urocyon cinereoargenteus cinereoargenteus:* Gray Fox

Old hunters agree that it was once fairly abundant, but it is rare now. In Carroll and Harrison counties the hunters reported that none had been taken for many years.

*Canis lycaon:* Wolf

Has been extinct for some seventy-five years.

*Felis couguar:* Cougar

Has long been exterminated (Brayton, 1882, p. 9).

*Lynx canadensis canadensis:* Canada Lynx

Brayton (1882, p. 9) lists this lynx, but no records of its occurrence are available.

*Lynx rufus rufus:* Bay Lynx

There are frequent newspaper reports of the capture of this large cat, but a large reward posted by a group of Columbus men has failed to produce any recent record of its existence in the state.

*Marmota monax monax:* Woodchuck

Occurs wherever the topography or degree of cultivation permits it to burrow. The woodchuck is very abundant on the Glaciated Plateau province, for here it can burrow in a hillside and live in plenty by visiting the fields that frequently come up to its door. Specimens were taken or seen in Ashtabula, Ashland, Wayne, Harrison, Carroll, and Ross counties. Not only does it occupy the rougher lands, but it is found in numbers on the "muck bottoms," where it burrows in the road embankments and in the higher portions that are free from flooding.

*Citellus tridecemlineatus tridecemlineatus:* Thirteen-striped Ground-squirrel

The ground-squirrel is extending its range to the east and south with the advent of prairie conditions. Specimens were taken at Columbus and Circleville and seen in Sandusky and Marrow counties. Thus it appears to be confined to the Plains region of the western part of the state. Further extension of the range is to be expected.

*Tamias striatus striatus:* Chipmunk

Taken in the Unglaciated and Glaciated Plateau provinces. It is very abundant in the open woods which have been cut, in brush, and in stony fields. Specimens were taken in Wayne, Ashtabula, Ashland, Harrison, Carroll, and Lawrence counties, and it was seen in Ross County. Though this species was reported from Butler County none were seen. A pregnant female was collected in Wayne County on August 21.

*Sciurus hudsonicus loquax:* Red Squirrel

The red squirrel is abundant in high dry woods throughout the Western Reserve. It is absent from much of the Unglaciated Plateau and from the southwestern portions of the Till Plains. Specimens were taken or seen in Ashtabula, Ashland, Wayne, and Harrison counties.

*Sciurus carolinensis leucotis:* Gray Squirrel

This squirrel is an inhabitant of the deeper woods. It appears to be absent from the region about Cincinnati. Specimens were taken in Wayne, Carroll, Harrison, and Ashland counties.

*Sciurus niger rufiventer:* Fox Squirrel

Found in more open woods than the gray squirrel. Specimens were seen or taken in Harrison, Wayne, Ross, and Ashland counties. In Wayne County it is more abundant in the woods on the "bottoms" and in wood-lots than the gray squirrel, but it is not so abundant, except in the woods on the "bottoms," as the red squirrel.

*Glaucomys volans volans:* Flying Squirrel

Taken in Ashland, Ashtabula, Wayne, and Harrison counties, but has a wider distribution than these records indicate. Specimens were not captured until it was learned that meat was the best bait. One was shot while it was eating bacon belonging to the camp store.

*Castor canadensis canadensis:* Beaver

Exterminated at an early date.

*Peromyscus maniculatus bairdii:* Prairie Deer-mouse

| | |
|---|---|
| Glaciated Plateau Province | |
| Orchard habitat | 3 |
| Ruderal habitat | 4 |

Reported from the sand dune area of Lake Erie (Nat. Guide, p. 357), from London, Madison County (Osgood, 1909, p. 82). This mouse was taken in a young orchard located on the top of a high, dry hill, along the road side, and in the weeds covering the "muck bottoms." All the specimens were captured in the Glaciated Plateau province, as it was here that they were searched for most systematically. This mouse is widely distributed in prairie regions, so that it is to be expected that it will occupy the central and eastern parts of the state as prairie conditions become established.

*Peromyscus leucopus noveboracensis:* Forest Deer-mouse

| | |
|---|---|
| Unglaciated Plateau Province | |
| Beech-maple | 29 |
| Oak-hickory | 57 |
| Glaciated Plateau Province | |
| Beech-maple | 42 |
| Oak-hickory | 19 |
| Till Plains Province | |
| Beech-maple | 36 |

The forest deer-mouse is distributed everywhere in the state. It inhabits woods, brush, or fence rows in equally large numbers. Specimens were taken in Ashland, Ash-

tabula, Butler, Carroll, Harrison, Hocking, Lawrence, Ross, and Wayne counties. It appears to be able to accommodate itself to a greater range of soil and moisture conditions than any other rodent found in Ohio.

*Oryzomys palustris palustris:* Cotton Mouse

Skulls of this species are abundant in the Baum Village site, but no record of its occurrence in recent times is available (Hine, 1910, p. 71).

*Neotoma pennsylvanica:* Rock Rat

The first specimen reported from the state was taken by Hine at Sugar Grove, Hocking County, in 1924. The rat is not confined to this locality, since reports of its occurrence have come from various places in this general region. One specimen reported from Scioto County appears to belong to this species. It occurs, probably, wherever connected cliffs offer it protection. Since these cliffs are confined to the region of sandstone or conglomerate of the Unglaciated Plateau province it is probable that the rat is confined to this province.

*Synaptomys cooperi:* Lemming Vole

"Widely distributed over the state and in some places common" (Hine, 1910, p. 690). I collected one specimen in Ashland County, where stems of grass cut and piled in bundles of ten or more stems were found in a field. Since the specimen was taken among the piles of grass it is suspected that they were the work of this species. The individual was a nursing female (July 10). No runways were apparent. Intensive trapping produced no *Microtus* or *Zapus*.

*Evotomys gapperi gapperi:* Red-backed Vole

One specimen was taken at Farnham, Ashtabula County. It was a young male and was captured along a small stream leading through woods composed of hemlock, white pine, and sugar maple. Though bogs occur in the general region no collecting was done in them.

*Microtus pennsylvanicus pennsylvanicus:* Field Vole

Abundant over all the state in fields and waste places. Specimens were taken in Ashland, Ashtabula, Butler, Harrison, Preble, and Wayne counties. In Ashland County a close study covering three seasons was made of a young orchard. In this orchard, which had been cleanly cultivated, the meadow vole did not occur until the third year, when a cover crop of timothy was permitted to grow. During the first two years the orchard was occupied by the prairie deer-mouse, but this mouse was not found the third year, after the meadow vole had invaded the habitat.

*Microtus ochrogaster:* Prairie Vole

This typical prairie form has been taken in Selby County (Henninger, 1921, p. 239). Because of its rarity Henninger believes that this is the eastern limit of its range.

*Pitymys pinetorum scalopsoides:* Pine Mouse

| | |
|---|---|
| Unglaciated Plateau Province | |
| Beech-maple | 4 |
| Oak-hickory | 6 |
| Glaciated Plateau Province | |
| Beech-maple | 3 |
| Till Plains Province | |
| Beech-maple | 1 |

Specimens taken in Harrison, Lawrence, Preble, and Wayne counties. Lawrence County, in the southern part of the state, appeared to be the region of greatest abundance. In habitats where they were numerous many of the specimens were partially eaten. Habitats occupied ranged from the very dry, as found on the high hills, to very moist banks of woodland streams.

*Ondatra zibethica zibethica:* Muskrat

Probably more abundant now than it was before the settlement of the state. State wide in distribution, living in houses in the marshes and "bottoms" and in burrows along the

streams and drainage ditches. It occurs in the very small streams as well as in the larger ones. Specimens were taken in Wayne and Ashland counties.

*Rattus norvegicus:* House Rat

Introduced, and now common in grain fields. None were taken in woods.

*Mus musculus musculus:* House Mouse

Introduced. Specimens were taken in a small marsh (Wayne County) and in dense woods (Harrison County) far from any house or fields. It appears to be better established than the rat in natural habitats.

*Zapus hudsonius:* Jumping Mouse

Without separating this species into its subspecies the following records are listed: Craigton and Wooster, Wayne County, and Carrollton, Carroll County.

*Napaeozapus insignis:* Woodland Jumping Mouse

A. Fuller, of the Cleveland Museum of Natural History, took this rare specimen at Mentor. It was captured in dense woods described as climax beech-maple.

*Erethizon dorsatum dorsatum:* Porcupine

Last reported to have occurred in the state in 1879 (Moseley, 1906, p. 505).

*Lepus americanus virginianus:*
*Lepus americanus americanus:* } Snow-shoe Hare

Formerly found in the northeastern portion of the Western Reserve "which is embraced in the Alleghenian fauna" (Brayton, 1882, p. 160). Thirty or forty years ago it was found in the adjoining counties of Pennsylvania (Rhoads, 1903, p. 119). No specimens from Ohio are available so no subspecific determination can be made. It is doubtful whether any hares survive, for in the portion of the state to

which they were confined heavy cover is scarce and there has been much hunting.

*Sylvilagus floridanus mearnsii:* Cottontail Rabbit

Abundant in fields and small woods over all the state. Specimens were recorded from Ashland, Ashtabula, Butler, Harrison, Carroll, Lawrence, Ross, Trumble, and Wayne counties.

*? Sylvilagus audubonii neomexicanus:* Western Cottontail

This species was first imported in the spring of 1926 by the Division of Fish and Game. Approximately 3000 "cottontail rabbits from Kansas" were distributed over the state. The method of distribution was to send the rabbits to centrally located points from which they were reshipped to local sportsmen's clubs for release. As a result the rabbits were a long time in transit and when finally released were not in good condition. Moreover, the habitats selected were not always suitable for this species.

*Cervus canadensis canadensis:* Elk

Records of former occurrence in Ohio are not rare. One was killed in Ashtabula County in 1838 (Kirtland, 1838).

*Odocoileus virginianus virginianus:* Whitetailed Deer

Deer were killed in Paulding County in 1881 and in Wood County in 1893. These may have escaped from captivity (Moseley, 1906, p. 504). The Division of Fish and Game has released deer in the Roosevelt Game Refuge, but appears to have no records of the number or point of origin.

*Bison bison bison:* Bison

"The buffalo and elk were not exterminated until about the year 1800" (Walker, 1869, quoted by Brayton, 1882, p. 80).

## Distribution of Mammals by Habitats

No correlation between either the totals or the averages of the common mammals taken in the two major habitats was found. The two most abundant species, the forest deer-mouse

(*Peromyscus l. noveboracensis*) and the short-tailed shrew (*Blarina b. talpoides*), were found in approximately equal numbers in the beech-maple habitat in the Unglaciated Plateau province. In the same habitat in the Glaciated Plateau province 71 deer-mice were taken and 42 short-tailed shrews; in the Till Plains province 36 deer-mice were taken and 34 short-tailed shrews.

In the oak-hickory habitat in the Unglaciated Plateau province 57 deer-mice were taken and 39 short-tailed shrews. This type of habitat in the Glaciated Plateau province yielded 19 deer-mice and 14 short-tailed shrews.

Several stations, located in the various provinces and habitats, yielded only one or the other species, but in most stations deer-mice and short-tailed shrews were taken in approximately equal numbers. The variations found could be explained by the condition of the forest floor in regard to moisture, logs, brush, and so on, and does not reflect any major differences in the habitat.

Neither the beech-maple nor the oak-hickory forest habitat is dominated by either of the two species named above to the exclusion of the other. Likewise it is found that neither of the two species is more abundant than the other in any given type of habitat. That each of the deer-mice (*P. l. noveboracensis* and *P. m. bairdii*) "is undoubtedly the most abundant mammal in the biotic association in which it occurs" (Johnson, 1926, p. 263) may be true in Illinois and Indiana, but is not true in Ohio in the case of the forest deer-mouse, as reference to the lists of specimens will show. In six stations the short-tailed shrew outnumbered the deer-mouse. The distribution of these stations was such that no relation between forest type or physiographic province appeared to influence the results. On the other hand, the forest deer-mouse was the most abundant mammal taken in ten stations located in the major habitats and again the distribution of the stations was such that no significant difference as to forest type or physiographic province was evident. Six of these ten stations were located in the beech-maple forest and three of the

stations in which the short-tailed shrew was the more abundant were also in this type of forest.

In every station where the forest deer-mouse was not the most abundant mammal the short-tailed shrew was, but the short-tailed shrew was not always second in point of abundance where the deer-mouse was first. This was true in many stations, but in one station (2) the smoky shrew (*Sorex fumeus fumeus*) was second in numbers to the deer-mouse and no short-tailed shrews were taken.

The mammals that were less numerous did not show as even distribution in regard to forest type as did the species discussed above. Species like the red-backed vole (*Evotomys gapperi*), the woodland jumping mouse (*Napaeozapus insignis*), Brewer's mole (*Parascalops breweri*), and some others do not range widely in Ohio, so that little can be done in the way of relating their distribution to forest type. They are of interest since they tend to show that variations in the mammal associations in the various forest types are largely dependent upon the occurrence of minor habitats within the major habitats or upon other zoögeographical factors.

### Distribution of Mammals by Physiographic Provinces

The only species of mammal that appears to be limited to the Unglaciated Plateau province is the rock rat, *Neotoma pennsylvanica*. Within the province it is confined to regions where outcrops of sandstone or conglomerate form cliffs, caves, or piles of rock in which the rats can live. Isolated habitats of this type are found in both the Unglaciated and Glaciated Plateau provinces, but they are not occupied. The area from which this species is reported is a region of connected ridges and cliffs. It is not unlikely that the absence of this type of topography is as effective a barrier to long migrations as it is a limiting factor, because of the need of the animal for this type of habitat for homes.

No mammal is confined to the Glaciated Plateau province. Several, however, reach their maximum abundance in this province. Brewer's mole, *Parascalops breweri,* has been re-

ported from the following counties: Adams, Summit, Cuyahoga, and Franklin (Hine, 1912, p. 496), Portage, Cuyahoga, and Mahoning (Jackson, 1915, p. 82), and Ashtabula, Wayne, and Harrison. This corresponds roughly with the limits of the Allegheny Plateau although Franklin, Cuyahoga, and Ashtabula counties are on the border. Jackson (1915, p. 77) states that the range of this species includes northeastern Ohio, but additional records show that the range must be extended to include most of the Allegheny Plateau. Hahn (1909, p. 647) says that this form may be found in Indiana, since it has been reported from a point near Cincinnati. The record upon which this statement is based is from Adams County, within the limits of the Plateau.

The masked shrew, *Sorex cinereus,* is reported from Mahoning, Summit, and Ashtabula counties (Hine, 1912, p. 495). The records indicate that the masked shrew is confined to the Allegheny Plateau.

The smoky shrew, *Sorex fumeus fumeus,* was taken in Wayne, Carroll, and Ross counties, being fairly abundant in the county last named. This species appears to be confined to the Allegheny Plateau and is more abundant in the Unglaciated Plateau province.

The star-nosed mole, *Condylura cristata,* has been reported from the following counties: Cuyahoga, Portage, and Mahoning (Jackson, 1915, p. 91), Mahoning, Summit and Ashtabula (Hine, 1912, p. 493), and Wayne. Records from Indiana (Hahn, 1909, p. 615) show that it is not confined to the Plateau, but the records for Ohio show that it occurs here in greater abundance than elsewhere. This is due, possibly, to the fact that the swampy conditions upon which it depends (Hahn, 1909, p. 615) tend to occur along the Ohio-Erie Divide (Sears, 1926a, p. 145; Coffey and Rice, 1915, p. 133.)

The short-tailed shrew, *Cryptotis parva,* has been reported from Portage (Merriam, 1895, p. 18), Ashtabula, Summit, Franklin and Hamilton counties (Hine, 1912, p. 495). This indicates a general distribution, but it does not appear to have been reported from the Unglaciated Plateau province. As

an inhabitant of grassy, brushy places (Hahn, 1909, p. 604; Howell, 1921, p. 22), it may be limited by the habitat. This type of habitat does not occur with any great frequency in the Unglaciated Plateau province. The absence of records from the region may, however, be due to the small amount of collecting that has been done in this province.

Without trying to separate the species of the Hudson Bay jumping mouse, *Zapus hudsonius,* into its subspecies, the following records may be assigned to the species: Mahoning (Vickers, 1894, p. 15), Meigs ? (Preble, 1899, p. 17), Summit (Hine, 1906, p. 551), Seneca, Scioto, Ross (Gossard, 1923, p. 285), Carroll, and Wayne counties. All these records, except the one from Seneca County, are from the Allegheny Plateau. Four are from the Unglaciated and three are from the Glaciated portion.

The prairie mole, *Scalopus a. machrinus,* has been reported from Cuyahoga, Fairfield, Hamilton, Columbiana (Jackson, 1915, p. 44), Franklin, and also as "distributed quite generally over western Ohio," but intensive trapping failed to produce it in Summit and Medina counties (Hine, 1915, p. 495). Though the prairie mole does occur on the Allegheny Plateau, it is more abundant to the west of this region.

The badger, *Taxidea taxus taxus,* is limited to the Till Plains province, although it may have formerly occurred in the drier portions of the Lake Plains. This mammal is a typical prairie form that was limited by its habitat requirements to the provinces named. That portion of the Lake Plains province where limestone occurred at the surface or where the wetter portions were covered with water at any time of the year formed an effective barrier to the extension of range of this species.

The thirteen-striped ground-squirrel, *Citellus tridecemlineatus tridecemlineatus,* appeared to have been confined, at the time this study was made, to the Till Plains province and Lake Plains province. The range of this ground-squirrel has been extended eastward with the spread of prairie conditions after the removal of the forest and the cultivation of

the land. This species is well established at Columbus and Circleville. Both these points lie within the Till Plains, but are near the eastern border of the province. The extension of range is due not so much to physiographic conditions as to the artificial conditions created by human occupation. Further spread is to be expected. To judge from the habitat selection of the species, the Glaciated Plateau province will be occupied before the Unglaciated Plateau, because of the development of prairie conditions on the former and because of the relatively little prairie-like area found on the latter. Maybe the physical character of the soil will retard the extension of range in this direction.

The prairie deer-mouse, *Peromyscus maniculatus bairdii,* has invaded the Glaciated Plateau province after the development of prairie conditions in the province. This mouse was taken by Hine (1910, p. 71) in Madison County. All of western Ohio is included in its range (Osgood, 1909, p. 79). The writer took it in 1923 in Ashland and Wayne counties, and in 1926 in Ashland County. That the distribution of this mouse is not governed by physiographic conditions is evident from the fact that specimens captured were taken on the top of a sterile, overdrained bluff, in "muck bottoms," and by roadsides. Wherever this mouse is taken it is caught in the open, the character of the soil or the amount of moisture present having, apparently, little to do with the distribution. Further extension of the range to the east is to be expected.

Of the typical prairie forms the prairie vole, *Microtus ochrogaster,* has been taken in Selby County (Henninger, 1921, p. 239). Henninger believes this to be the eastern limit of the range. This species may have spread into Ohio after the development of the type of habitat that it requires.

Too few records of the lemming vole, *Synaptomys cooperi,* are available to make it of value to this study. It has been reported from Madison and Summit counties (Hine, 1910, p. 69) and from Ashland County. These records are from the Till Plains and Glaciated Plateau provinces.

The red-backed mouse, *Evotomys gapperi,* known from but a single specimen, was taken in Ashtabula County. This confines it to the northeastern portion of the state, where the physiographic provinces approach each other closely. It is doubtful whether the range is limited as much by physiographic factors as by habitat or temperature conditions or a combination of ecological factors only slightly affected by physiography. On the other hand, distribution may be governed by the presence of the northern bog type of habitat which results, in this region, from a combination of physiography, temperature, and the possibility of seeding to the bog association. A depression to hold water is physiographic, the temperature and rainfall are climatic, but the bog type of habitat is due, possibly, to long establishment or chance seeding. This latter can be seen in associations surrounding some of the recently made ponds where the association is of the marsh type while the older depressions are occupied by bogs.

The woodland jumping mouse, *Napaeozapus insignis,* has been collected near Mentor, located in the Lake Plains. This fact is not as significant as the nearness of the Transition forest. The distribution of this mammal in Pennsylvania leads to the conclusion that it reaches the border of its range in the northeastern part of Ohio.

### Summary of Distribution by Physiographic Provinces

Only one mammal, the rock rat (*Neotoma pennsylvanica*), is confined to the Unglaciated Plateau province.

The smoky shrew (*Sorex fumeus fumeus*) is confined, apparently, to the Allegheny Plateau.

The badger (*Taxidea taxus taxus*), the thirteen-striped ground-squirrel (*Citellus tridecemlineatus*), and the prairie vole (*Microtus ochrogaster*) appear to be limited to the Till Plains or the drier portions of the western Lake Plains.

The prairie mole (*Scalopus a. machrinus*), the short-tailed shrew (*Cryptotis parva*), the prairie deer-mouse (*Peromyscus maniculatus bairdii*), and the lemming vole (*Synaptomys*

*cooperi*) are confined to the Till Plains and Glaciated Plateau provinces.

The mammals that appear to be most abundant on the Allegheny Plateau are Brewer's mole (*Parascalops breweri*), the star-nosed mole (*Condylura cristata*), and the jumping mouse (*Zapus hudsonius*).

The prairie mole (*Scalopus a. machrinus*) and the prairie deer-mouse (*Peromyscus maniculatus bairdii*) appear to be most abundant in the Till Plains province.

The red-backed vole (*Evotomys gapperi*), and the woodland jumping mouse (*Napaeozapus insignis*) are confined to the northeastern portion of the state where the Glaciated Plateau province meets the Lake Plains province.

It is evident that physiographic provinces do not offer an entirely satisfactory method of stating distribution in a region where the same climax and subclimax forest extends over several provinces. However, one species of mammal is confined to the Unglaciated Plateau province, two species to the Till Plains province, and twelve do not enter the Unglaciated Plateau province. Of these twelve species five are typically prairie mammals, three are northern species, and one is an inhabitant of swamps and marshes, which are lacking in this province, as are also prairie-like areas.

All the mammals that do not range through two or more physiographic provinces are confined to minor habitats. The slight differences in the mammalian fauna in the several physiographic provinces are due to the occurrence of minor habitats within the provinces and not to major differences between the physiographic provinces.

## Summary

Four well-defined physiographic provinces are found in Ohio. These are the Till Plains province, the Lake Plains province, the Glaciated Plateau province, and the Unglaciated Plateau province.

Two major types of forest habitat occur in the state. Beech-maple is the more common type in the Till Plains

province; oak-hickory is more abundant in the Unglaciated Plateau province. The Glaciated Plateau province supports beech-maple and oak-hickory over approximately equal areas. The distribution of these forest types is only indirectly correlated with the physiographic provinces.

No significant difference was found between the mammal communities of either the beech-maple or oak-hickory of the several physiographic provinces. Such differences as were found are due to the presence of minor habitats within the major habitats in the several physiographic provinces.

The use of physiographic provinces is not adequate for the statement of the distribution of mammals in Ohio.

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